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MIXTURE FOR FABRICATION OF WATER-SOLUBLE CORES
[SMES DLYA IZGOTOVLENIYA VODORASTVORIMYKH STERZHNEY]

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1. Mixture for fabrication of water-soluble cores of complex shape, including sodium chloride and a surfactant, characterized in that in order to raise the quality of castings of aluminum and its allows, it additionally contains a water-soluble phosphate-containing compound and water in the following ratio of ingredients, percent by mass:

Water-soluble, phosphate-containing compound:	3-6
Water	10-14
Surfactant	0.01-0.03
Sodium chloride	the rest

2. Mixture in accordance with claim 1, characterized in that it contains an alumochromophosphate binder in the capacity of the phosphate-containing water-soluble compound.

3. Mixture in accordance with claim 1, characterized in that for the purpose of complete regeneration of the mixture, it contains sodium polyphosphate in the capacity of the phosphate-containing water-soluble compound.

4. Mixture in accordance with claim 1, characterized in that for the purpose of accelerating hardening of the mixture during molding of the cores, it also contains soda in a ratio of (2-3):(1-2) with the sodium polyphosphate.

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The invention relates to the casting industry, in particular to compositions of core mixtures for fabrication of water-soluble cores used for the casting of aluminum and its alloys.

The object of the invention is to raise the quality of castings with cavities of complex form made of aluminum and its alloys.

The water-soluble phosphate-containing compound (alumochromophosphate ACP binder and sodium polyphosphate) used in the proposed mixture interacts with the sodium chloride, which results in increased chemical resistance of the latter to melts of aluminum and its alloys.

In the process of drying, along with the removed water, there is migration of the PO^{3-}_4 ions to the surface layers of the item. With further heat treatment, a thin layer of aluminum and chromium phosphates forms on the item surface (when ACP binder is used), as well as compounds of sodium phosphate with sodium chloride (when ACP binder or sodium polyphosphate is used). These compounds possess enhanced resistance to melts of aluminum and its alloys in comparison with NaCl. As a result, the quality of the castings is improved, since the interaction of the core with the casting is reduced.

It is preferable to use an ACP binder with a density of 1.9 g/cm^3. As an inorganic glue, the ACP binder assures strength of the item after molding, and reduces the temperature of sintering. The use of more than 6 % by mass of ACP binder (referred to the dry material) hampers drying of the molded items, and during drying, specimen

swelling is observed. A quantity of ACP binder of less than 3 % by mass does not assure the needed strength of the items. In order to impart better plasticity to the mass, the ACP binder is diluted with water to a density of 1.55 g/cm^3. As a result of heat treatment, the ACP binder is polymerized, with formation of low-soluble compounds. When such cores are dissolved, the leaching time increases somewhat, and the ACP binder is irretrievably lost.

The use of sodium polyphosphate makes it possible to obtain somewhat less robust cores than when ACP binder is used, but they dissolve more quickly and without residue, which makes it possible to fully regenerate the mass. The strength of the core after molding, and the possibility of extracting it from the mold, is assured by the capacity of the sodium polyphosphate to form crystal hydrate $Na_3PO_4 \cdot 12H_2O$. A Na_3PO_4 content of less than 3 % by mass is insufficient to assure the necessary strength of the molded item when it is extracted from the mold after plastic molding. When the content of the Na_3PO_4 is more than 6 %, a degradation of the item surface is observed, owing to subsequent desalting during drying.

To speed up hardening of the mixture, soda is added to the sodium polyphosphate. $Na_2CO_3 \cdot 10H_2O$ binds a larger quantity of water (63 %) than $Na_3PO_4 \cdot 12H_2O$ (57 %). In addition, the basic nature of the soda accelerates the processes of polymerization in the sodium polyphosphate. All this leads to a marked acceleration of mixture

hardening during molding of the cores. When the ratio of soda to sodium polyphosphate is more than 2/3, interaction with the melted aluminum and its alloys is observed, which degrades the surface of the casting. With a ratio less than 1/2, the advantage of Na_2CO_3 in water binding is not realized. The use of Na_2CO_3 accelerates mixture hardening, but it has a basic nature, and promotes interaction with melted aluminum and its alloys.

To assure plastic molding, the quantity of water must be no less than 10 % by mass. When the water content is more than 14 % by mass, the item is poorly extracted from the mold, and has a rough surface.

The content of surfactant (for example, detergent powder for laundering in sea water—Lotos, Neptun, etc.) of less than 0.01 % by mass does not give an adequate positive effect, while an increase above 0.03 % by mass is not necessary, since at this point further improvement in plasticity is not observed, but there is an increase in gas emission owing to breakdown of the surfactant.

Examples of compositions and properties of the obtained specimens are shown in the table.

Example	Composition of mixture, % by mass									Comp. strength MPa	Coeff. of th. expans.	Detergent	Readings
	NaCl	ACP (dry)	Na3PO4	Na2CO3	Na2CO3: Na3PO4	H2O	surfactant	Al2O3	Paraffin				
1	79.97	6	-	-	-	14	0.03	-	-	46	43	Lotos	-
2	83.98	4	-	-	-	12	0.02	-	-	44	42	Neptun	-
3	86.99	3	-	-	-	10	0.01	-	-	41	43	same	-
4	89.995	2	-	-	-	8	0.005	-	-	20	42	"	Low plasticity
5	75.96	8	-	-	-	16	0.04	-	-	35	43	"	desalting
6	79.97	-	6	-	-	14	0.03	-	-	36	43	"	-
7	83.48		4.5	-	-	12	0.02	-	-	33	42	"	-
8	86.99		3	-	-	10	0.01	-	-	32	42	Lotos	-
9	89.995	-	2	-	-	8	0.005	-	-	15	42	Neptun	Poor surface low plasticity
10	75.96	-	8	-	-	16	0.04	-	-	35	43	same	desalting
11	79.97	-	3.6	2.4	2:3	14	0.03	-	-	30	43	"	-
12	83.48	-	2.84	1.66	7:12	12	0.02	-	-	32	42	Lotos	-
13	86.99	-	2	1	1:2	10	0.01	-	-	34	43	same	-
14	89.995	-	1.5	0.5	1:3	8	0.065	-	-	15	43	Neptun	Low strength
15	75.46	-	4	4	1:1	16	0.04	-	-	40	42	Same	Poor casting surface
Known Mixture	-	-	-	-	-	-	2.25	6	14	20	42	-	Bad casting surface

When ACP binder is used in the capacity of the water-soluble phosphate-containing compound to obtain the items, NaCl is ground to a grain size of less than 80 µm, heated to 40-60° C, and mixed with ACP binder heated to the same temperature, after it is first saturated with sodium chloride. The items are fabricated by the method of plastic compression at a pressure of 1-9 MPa, which makes it possible to mold an item of complex shape.

When sodium pyrophosphate or its mixture with soda is used in the capacity of the water-soluble phosphate-containing compound to obtain the items, the mixture of NaCl, sodium pyrophosphate, or its mixture with soda, H_2O and surfactant (Lotos, Neptun) are ground in a planetary mill for 3 minutes, and then the mixture is heated to 70-90° C. The crystallized water is extracted and together with the surfactant imparts sufficient plasticity to the mass to fill complex molds at a compression pressure of 10 MPa. The formation of the crystal hydrates leads to an increase in strength, which makes it possible to extract the item from the mold.

From the masses obtained, cylinders with a diameter of 25 mm and height of 50 mm are molded to determine compression strength; test beams of 5 x 5 x 30 mm for determining the coefficient of thermal expansion; and cores for filling with metal. The specimens are dried slowly, and then annealed at a temperature of 300° C for 1 hour. The

degree of interaction with the melted aluminum and its alloys is evaluated visually, comparing the surface of the core with the surface of the casting. Degradation of the casting surface in comparison with the surface of the core points to their interaction.

Examples 4, 5, 9, 10, 14, and 15 contain mixtures outside of the proposed intervals. Going past the lower boundaries of the intervals (examples 4, 9, and 14) leads to degradation of the item surface owing to the low plasticity of the mass; going past the upper boundaries of the intervals (examples 5, 10, and 15) hampers drying of the specimens, resulting in desalting, which degrades the surface of the specimens. In addition, an increase in the content of the soda in the mixture with sodium polyphosphate (example 15) leads to interaction with the melt of aluminum and its alloys.

For comparison with the known mixture, from a mixture containing, percent by mass: Al_2O_3 6; stearin 2.25; paraffin 14; NaCl 77.75; by the method of casting from a paraffin slurry, cylinders are formed which are 50 mm in height, with a diameter of 25 mm, to determine compression strength; beams of 5x5x30 mm to determine the coefficient of thermal expansion, and cores for filling with metal. The specimens are annealed in a charge of finely dispersed Al_2O_3 at 750° C for 2 hours. After filling with melted aluminum and its alloys, thinning of the surface of the casting is observed in comparison with the core, which indicates interaction.

The use of the proposed mass greatly simplifies the technology: there is no need to use a special unit for casting of the paraffin slurries; paraffin and stearin are not used and thus are not lost; work conditions are improved for the workers, since there is no gas emission from the breakdown of paraffin and stearin. From the proposed mass, only vapors of water are emitted, and a very small quantity of gases from the surfactant. Annealing does not have to be done in capsules in a charge of adsorbent; that is, there is no need for capsules, and or for their manual loading and cleaning of the cores to remove adsorbent.

The temperature of heat processing of the cores is reduced from 700 to 300° C, that is, by 400° C, which saves electricity and simplifies attainment of the given temperature. The drying mode can be accelerated with the use of vacuum-ammonium drying.

Cores made from the proposed mass interact much less with the melted aluminum and its alloys, which makes it possible to obtain good purity of casting surface. They can be stored for a sufficiently long time in the air without changing their properties. After being filled with metal and cooled, the cores are easily removed, since they have great porosity, which can be regulated by the compression pressure.

The use of vibration and surfactant solution makes it possible to remove most of the mass in the form of a suspension, to regenerate it

by water evaporation, and to use it again, which makes it possible to create waste-free technology.

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To mold cavities of complex form during casting of aluminum and its alloys under pressure, cores made of zinc are used, which are selected in the capacity of a known object. To prevent interaction of the zinc with the aluminum, it is necessary to galvanically coat the cores with copper. During melting of the core, the zinc may not entirely flow out of openings of complex shape, and overheating of it for more complete removal of the zinc leads to deformation of the aluminum items, which degrades the quality.

The proposed mixture based on water-soluble sodium chloride makes it possible to refrain from using scarce zinc. The technology of fabrication of the cores is simplified, since it occurs at room temperature. Simplification of the process of core extraction from the casting makes it possible to easily automate it. The absence of melts of zinc, whose vapors are toxic, improves the working conditions. The quality of items is also increased, since cores of the proposed mass are easily extracted from cavities of complex shape, and there is no danger of deforming the item because of the heating necessary for full removal of a zinc core.